Arizona Public Service Company
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January 27, 1984
ANPP-28733-BSK/KCP

U. S. Nuclear Regulatory Commission
Region V
Creekside Oaks Office Park
1450 Maria Lane - Suite 210
Walnut Creek, CA 94596-5368

Attention: Mr. T. W. Bishop, Director
Division of Resident
Reactor Projects and Engineering Programs

Subject: Interim Report, Revision 1 - DER 83-49
A 50.55(e) Potentially Reportable Deficiency Relating to
Br[illegible]n Impeller Blades and Diffuser Bolts Broken/Loose In
[illegible]actor Coolant Pumps
File: 84-019-026; D.4.33.2

Reference: A) Telephone Conversation between P. Narbut and R. Tucker on July 15, 1983
B) Telephone Conversation between T. Young and R. Tucker on July 18, 1983
C) ANPP-27593, dated August 19, 1983 (Interim Report)
D) ANPP-28734, dated January 27, 1984 (DER 83-50 Interim Report, Revision 1)
E) ANPP-28313, dated November 29, 1983 (Time Extension)

Dear Sir:

The NRC was notified of two potentially reportable deficiencies in References (A) and (B). Interim Reports were submitted in References (C) and (D), and a Time Extension requested in Reference (E). At that time, it was estimated that a Final Report would be submitted by January 27, 1984.

Due to the duplication of information and reporting involved, DER 83-50 is being combined with and transferred to DER 83-49, in accordance with the revised Interim Report attached and as discussed with Mr. Paul Narbut of your office. It is expected that this information will be finalized by June 15, 1984, at which time a complete report will be submitted.

Very truly yours,

E. E. Van Brunt, Jr.
APS Vice President, Nuclear
ANPP Project Director

EEVB/KCP:pt
Attachment: CE Doc. No. CEN-271(V)-P
Proprietary Copy #1

cc: See Page Two

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C E Doc. No. CEN-271(V)-P
Proprietary Copies

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File: DER 83-49	#38

* Non-proprietary copy attached.

INTERIM REPORT - REVISION 1 - DER 83-49
POTENTIAL REPORTABLE DEFICIENCY
ARIZONA PUBLIC SERVICE COMPANY (APS)
PVNGS UNIT #1

I. Potential Problem

After precore hot functional testing, the PVNGS Unit 1 Reactor Coolant Pump (RCP) 1A was disassembled to excavate a linear indication in the pump casing circumferential weld. An inspection of the pump internal assemblies revealed four (4) broken and two (2) loose diffuser to casing retaining cap screws. Additionally, ten (10) of the diffuser to suction pipe cap screws were found to be loose. There was also slight cavitation damage observed on the leading edge of seven (7) diffuser vanes.

As a result of this inspection, the other three (3) Unit 1 RCP's were subsequently disassembled and inspected. In addition to discovering loose and/or broken diffuser and suction pipe cap screws, the following discrepancies were found:

1. The pump casings had sustained fretting or peening damage.

2. The leading edges, of one impeller vane on RCP 1B and two (2) vanes on RCP 2A, were missing segments. Impeller and diffuser degradation was observed.

3. There were broken and/or loose impeller key retaining screws, shaft protection sleeve key retaining rings, and carbon journal bearing key retaining screws.

4. The shaft seals showed wear on the stationary seal ring holders, and heavy deposits of O-ring lubricant throughout the seal assemblies. It was also reported that bolts in the seal cartridges were loose.

5. Leakage was observed between the carbon bearing sleeve and the seal housing indicating seal ring failure.

6. Surface indications such as scratches, burrs, wear marks, and ARC strikes were also observed.

The PVNGS Reactor Coolant Pumps are supplied by Combustion Engineering (C-E) and are designed by KSB of West Germany.

II. Approach to and Status of Proposed Resolution

C-E has reviewed the potential failure mechanisms and their consequences. These include a locked rotor, degraded pump coast down and core flow blockage. The results of the investigation are as follows:

II. Approach to and Status of Proposed Resolution (cont'd)

4) The function of the key retaining screws is to hold the keys in place during assembly operations. Once the impeller and carbon journal bearing is assembled, the keys and retaining screws are captured within the assemblies. Failure or loosening of the key retaining screws will not affect pump operability or result in discharge of parts in the RCS. The loose bolts in the seal cartridges are attributed to the high vibration levels experienced because of the impeller and diffuser deficiencies previously reported. Since the seal cartridges are above the water lubricated bearing, any bolts or seal parts could not pass through the close clearance bearing into the RCS.

5) The purpose of the seal ring between the bearing sleeve and the seal housing is to prevent the exchange of water between the pump casing/impeller discharge area and the cooler water lubricated carbon bearing area. Leakage past the seal ring could upset water circulation within the bearing, however, the bearing would continue to function and would not affect pump coast down capabilities.

6) The total assessment of the effect of the aforementioned deficiencies shows that the Reactor Coolant Pumps will maintain sufficient flow to satisfy the criteria set forth in the safety analysis.

An intensive program was initiated by C-E, C-E KSB, and KSB (West Germany) to determine the causes of these deficiencies, and the modifications necessary to correct the problems. Additionally, a program to verify the modifications by model and prototype testing has been established. The programs completed or presently underway are as follows:

1) Model tests with increased impeller/diffuser gaps to evaluate the reduction in pressure loadings on the diffuser/casing and diffuser/suction pipe joints. The model tests are necessary to determine the effectiveness of increased gaps to eliminate the diffuser vane leading edge cavitation.

   Model tests also verify known impeller stresses, and look for additional loadings which may result from higher than anticipated runout flows.

2) A complete evaluation of the diffuser and suction pipe cap screw stresses considering imposed loads, bolt preload, dimensional tolerances and stack-up and assembly techniques.

II. Approach to and Status of Proposed Resolution (cont'd)

3) A metallurgical investigation of the adequacy of the cap screw and impeller materials. Preliminary results show that both the cap screws and impellers are in compliance with the required material specifications.

4) Prototype testing in the CE-KSB test loop to collect base line data on the hydraulic components as originally designed and as modified. This testing also includes verification of the adequacy of diffuser retention modifications.

5) Examination of the broken impeller key retaining screws indicated that the sockets in the heads were formed too deep. This resulted in insufficient wall thickness in the head to shank area. The replacement screws have been redesigned with a large head to accommodate the socket. Tighter manufacturing control has been employed to insure that the sockets are not broached too deep. These screws will also be installed with retaining sleeves and staked in place.

   The shaft protection sleeve and carbon journal bearing key retaining screws are smaller screws and their looseness is attributed to high pump vibration. The method of torquing these screws and the possibility of staking them is being investigated.

6) The bearing sleeve to seal housing seal ring will be replaced with a flexitallic type gasket. The size of the bolts in the joint has been increased to insure that the gasket is properly seated.

7) The solution to the shaft seal deficiencies are not as critical and the investigations are more long term. Excessive "O" ring lubrication can lead to reduced seal life and instructions will be issued on the proper use of the lubrication. Precautions will also be taken to insure that the seal cartridge bolts are properly torqued.

8) A special test program for Unit 1, to demonstrate the adequacy of the modifications to the Reactor Coolant Pumps, will take place prior to fuel load. An operating sequence has been developed to test the modified components, under conditions similar to those during which the damage occurred. This program is scheduled for April 1984.

II. Approach to and Status of Proposed Resolution (cont'd)

1) The discovery of loose and/or broken diffuser bolting could cause diffuser movement and subsequent impeller binding. However, during full power operation hydraulic forces alone can maintain the diffuser in place. Only during start-up or coast down is there any potential for axial movement of the diffuser. The design is such that the diffuser-suction pipe assembly is captured radially throughout any axial movement. The diffuser cannot rotate because it is restrained by two (2) keys which engage the mating pump casing ledge. With these design features, the potential for impeller binding is remote during start-up and coast down.

2) Loose diffuser to suction pipe cap screws resulted in some movement of the diffuser/suction pipe assemblies as evidenced by wear on the suction pipe seating surface and the diffuser ledge in the pump casing. However, there was no evidence of impeller binding. The keys in the diffuser to casing joint prevented radial movement of the diffuser halves. The RCP's with the broken impeller vanes did show some minor scratching on the impeller wear surfaces, but not of sufficient magnitude to affect pump coast down.

3) The potential for core flow blockage has been examined, and it has been concluded that the observed deficiencies would not lead to flow blockage.

   The radial gap between the impeller and diffuser is small enough to prevent the escape of particles that are large enough to cause local flow blockage. This conclusion was verified in RCP 1A, in that the three (3) broken diffuser cap screw heads which came free from their locking sleeves did not pass through the impeller/diffuser gap.

   The broken impeller vane segments were found in the flow skirt of the reactor vessel because they were too large to pass through the flow skirt. The long cracks found in the damaged impellers indicate that any additional segments would be too large to pass through the flow skirt.

   Any particles generated from the diffuser vane leading edge cavitation would be microscopic in size, and would not lead to core flow blockage. The diffuser vane cavitation observed was minor and no material was found in the Reactor Coolant System (RCS) which could be identified as diffuser material.

II. Approach to and Status of Proposed Resolution (cont'd)

9) Bechtel will implement the required corrective action prior to the above mentioned demonstration test via the following Design Change Packages (DCP's).

1SM-RC-107
1SM-RC-109
1SM-RC-113

Additionally, these changes will be implemented in Units 2 and 3 prior to fuel load via DCP's.

2SM-RC-107	3CM-RC-107
2SM-RC-109	3CM-RC-109
2SM-RC-113	3CM-RC-113

These DCP's will provide the corrective action disposition of NCR's SM-2657, -2658, -2659, and -2660.

Additional information is provided in the attached C-E Interim Report, "Palo Verde Nuclear Generating Station Unit #1 Reactor Coolant Pumps (Proprietary)."

III. Projected Completion of Corrective Action and Submittal of the Final Report

Evaluation of this condition and submittal of the Final Report is forecast to be completed by June 15, 1984.